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NEW INFORMATION TECHNOLOGY

AND

SPATIAL TRANSPORT DEVELOPMENT*

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Abstract

This paper gives an overview of recent transport developments taking place at the European scene. Particular attention is given to the impacts of technological dynamics as reflected in the new information technology (NIT). Against this background the paper gives an overview of results and findings from four major international conferences on the impact on NIT on spatial developments and transportation. There appears to grow a concensus that the impacts of NIT will not be dramatic and that the degree of substitutability of NIT vis-à-vis physical travel is limited. Peripheral areas seem to become also in the area of NIT latecomers. However, in terms of the increase of a region's competitive position NIT may be an important vehicle. The same holds true for logistic systems and traffic safety.

1. Prologue

The spatial distribution of human activities induces various types of geographical interaction and communication patterns at local, national and international levels. Thus bridging of space, reflected in the demand for transport and communications, is a derived demand dependent on the kind of activity; at the same time, it involves by necessity consumption of time. As time is a scarce commodity, transport and communications are cost factors which have to be economized. Thus there is an inherent tendency from the side of the user of transportation services to ask for efficiency and quality improvement. Can these - usually conflicting - needs be satisfied?

In the recent past fairly drastic changes have taken place in most European transport systems, not only in terms of persons transport, but also in terms of freight transport and of information/communication flows. A few megatrends will be mentioned here (see Button and Gillingwater 1986, and van Gent and Nijkamp 1987).

In the field of persons transport the following developments can be observed inter alia:

- a demographic aging process which in the long run will have large consequences for car use and car ownership;
- a social trend towards more, but smaller and alternative types of households leading to higher spatial mobility patterns;
- an economic trend towards increased female labour force participation and more part-time jobs which necessitate a higher car use;
- a geographical trend toward more urban sprawl thus inducing more commuting;

Also in the field of commodity transport various new trends can be identified, such as:

- a dematerialisation tendency implying the production and transport of more and more high value, low weight commodities;
- a diversification in consumption marked by distinct but smaller product series, which affects the position of bulk transport;
- a trend toward multi-modal transport of previously competitive modes, for instance, road-rail transport (hucke-pack, e.g.) and road-air transport;
- a strong informatisation induced by the new information technology (NIT) and leading to an improvement of the logistic organisation of transport (reflected inter alia in the JIT-principle, e.g.);

- a globalisation of the European economies (especially after 1992) inducing the emergence of transnational shipping companies.

Finally, in the field of information/communication flows also various trends are emerging, such as:

- an intensification of the exchange of knowledge or information in relation to both persons and freight transport;
- an increasing importance of telecommunication as both a substitute and a complement to physical interactions;
- a growing importance of telematics as a means for improving the efficiency of current infrastructures;
- a tendency toward more flexibilisation of economic activities (e.g., a rise in teleshopping, telecommuting etc.).

It goes without saying that the above mentioned socio-economic and technological megatrends shape to a large extent the conditions for drastic changes in spatial mobility and interaction patterns. In the context of the present paper we will focus our attention in particular on the question whether - and to which extent - new technologies may drastically affect the flows of persons, commodities and information.

2. Technological Dynamics

In the framework of the transport technology debate, it is sometimes claimed that - until the turn of the century - transport policies will be affected only within the context of currently existing technologies. This would imply that in the short and medium term no major new (revolutionary) modes of transport will come into being. At best, the quality and efficiency of current modes of transport would be improved.

However, such an incremental view on transport planning may be at odds with a life-cycle notion regarding transport modes (see Marchetti 1987). The underlying idea is that transport modes - like any other commodity category - exhibit a product life-cycle marked by phases of take-off, adoption, market penetration, large-scale use, saturation and declining market shares. Thus transport modes will tend to show a history beginning with a period of low-volume high-cost adoption, followed by further expansion and improvement and ended with general acceptance and wide-spread use (see Le Clercq 1987). Clearly in a way parallel to transport technologies, also transport management styles will exhibit similar life-cycle phenomena. Technical change may intervene here by

providing new hardware to facilitate better control or enhance the quality of information which is available to management.

Now the question is whether it is plausible that technological progress in the transport sector - taking for granted the various phases of a product life-cycle - is showing an accelerating evolutionary pattern in the foreseeable future, and that before the turn of the century new patterns of spatial interactions will emerge.

Even when no new technologies would become available in the near future, still drastic changes in the flows of persons, goods and information might emerge, notably for two reasons.

In the first place, we see increasingly a shift in emphasis from isolated transport modes toward an integrated systems technology. This implies a more efficient use and management of all (sometimes competing) transport infrastructures (e.g., combined transport via roll-on roll-off techniques). Such developments based on synergetic spill-over economies may - even with the current level of network capacity - alter qualitatively and quantitatively the European transport scene at local and (inter)national levels, even in the foreseeable future. The open European market in 1992 will certainly induce such new developments.

Next, it is noteworthy that an open European market will supposedly generate a high degree of internationalisation of all national economies thus inducing an increase in international freight transport, in international commuting and in international telecommunications services. Given the existing and foreseeable constraints on various transportation modes in several European countries, it is plausible that in the medium term intermodal substitution and multi-modal orientation in European transport systems will emerge (see also Noortman 1988).

Clearly, in the long run completely different transport modes may be expected, since according to Marchetti (1987) various current modes of transport (train, bus, private car) are in the final phase of their life-cycle (see also Figure 1). Especially the current revolutionary changes in the field of superconductivity may induce a new generation of rapid, environment friendly and energy saving transportation vehicles (see also Marchetti 1987 and Nakicenovic 1987).

It schould be noted, however, that the life cycle pattern of transport systems reflected in Figure 1 takes for granted a fixed technology and fixed organisational/institutional structures. If these preconditions change, existing transport modes may be renewed and gain again popularity. This is well illustrated by the present trend toward high speed trains, in which the old railway technology is linked with

new materials technology and information technology in order to shape a new transport vehicle that is beginning a new life cycle on top of the previous life cycle.

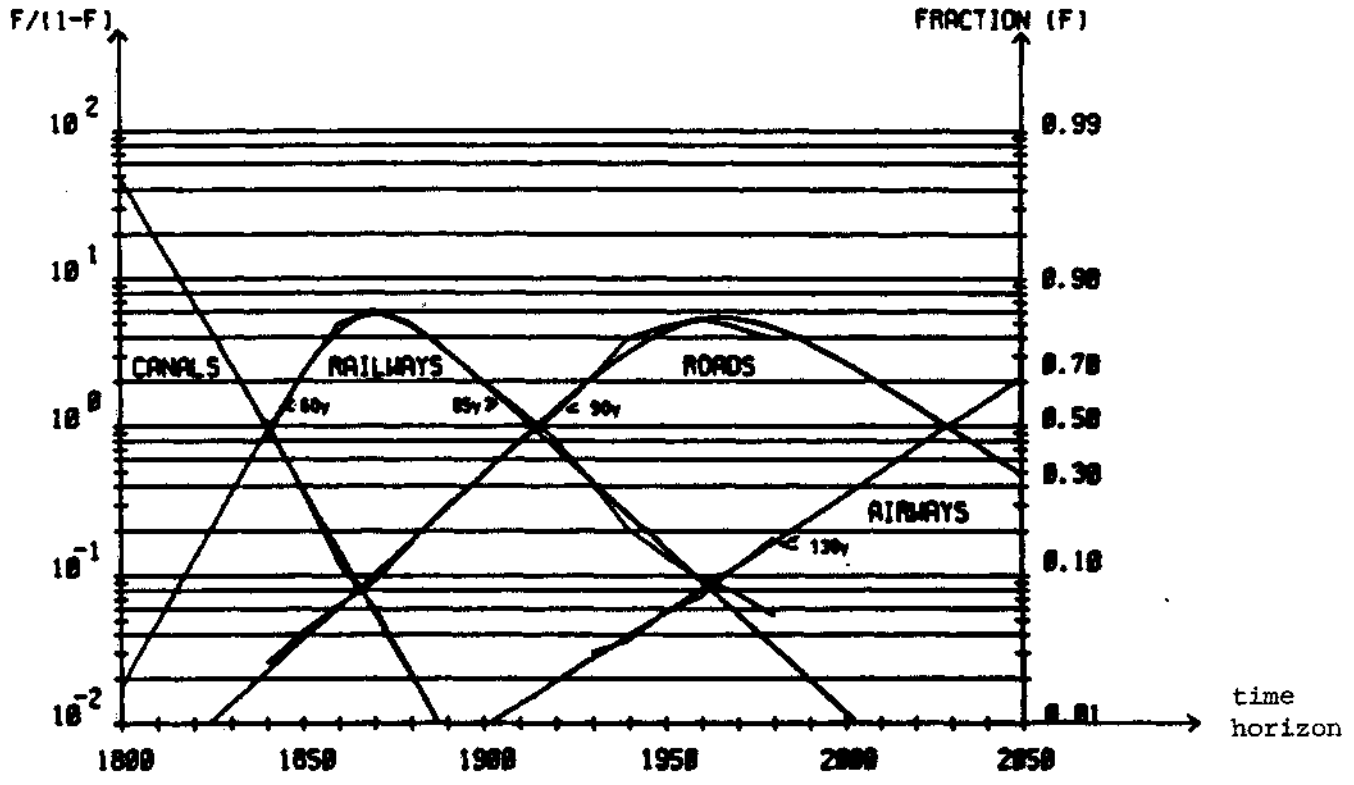

Figure 1. Competition between transport modes seen from a life cycle perspective.

Legend : F = share of a given transport mode (right-hand vertical axis)

F/(1-F) = logit of a given transport mode (left-hand vertical axis)

Source: Marchetti (1987)

It is clear that the prediction of technological trends is fraught with many uncertainties (see also Biéber 1986). Given the experience in the private sector that R&D and investments are usually oriented toward sectors with relatively long-term financial rewards, it is likely that especially new transport policies with an emphasis on efficient management and control, small environmental impacts and a high degree of polyvalence may become the winners in the competition for new transport

modes. In this framework, it should also be noted that the transport sector cannot be treated in isolation from other industrial sectors and the service sector, as changes in the transportation system are to some extent also responses to changes elsewhere in the system. Recent advances in information technology may imply that alternatives to transport are increasingly emerging, which may be adopted quite rapidly in order to replace conventional transport inputs.

3. Changes at the European Scene

It goes without saying that the enhancement of Europe's competitive position in the international economic community will to a large extent depend on a collective effort to develop and use innovative and strategic transport/communication knowledge, technologies and infrastructures (cf. Giaoutzi and Nijkamp 1988), which may lead to a replacement of many outdated transport systems. In this respect there is much scope for joint European policies, inter alia in the field of:

- the design of a high speed train network, which may be seen as the successor of the conventional railway technology (i.e., based on a new life cycle; see section 2)
- the integration of information transmission with sectors outside the transport sector (e.g., the COST programme of the European Community focussing on the use of informatics and telematics in transport technologies);
- the construction and expansion of the Trans European Motorway (TEM) linking Western Europe with the Middle East;
- international cooperation regarding the design of new motorways and railways (e.g., with respect to the Iberian Peninsula);
- research programmes on transport safety and risk perception, and international cooperation in vehicle design and construction;
- abatement policies on environmental impacts of transport (based on more strict regulations);
- European-wide cooperation on multi-modal transport (with a specific view on inland waterways and seaports);
- coordination of telecommunication (e.g., with respect to the gradual introduction of broadband communication services at Community level by 1992);
- design of new navigational systems and electronic travel aids (e.g., dashboard mounted video display screens);

- design of advanced infrastructure based on telematics (e.g., digital public-switched networks, satellite by-pass facilities, teleports, city cabling schemes, etc.).

In many recent studies the evolution of transport systems is considered from the viewpoint of the information society. In combination with a European free market as of 1992 new forms of spatial structure and geographical organisation are likely to emerge. Such a geographical restructuring may take place at both an (inter)national scale (e.g., via a change in core-periphery relationships, new corporate spatial organisations, a new spatial division of labour) and a local scale (e.g., via the emergence of teleworking or teleshopping, the rise of new forms of spatial dominance caused by newly emerging European metropolises like Milano, Paris, Brussels, the Dutch Randstad, etc. (see also Gillespie and Hepworth 1988).

Clearly, the prediction of changes at a broader European level is fraught with many uncertainties. However, the trend toward more integrated systems technologies is bound to take place, and hence new transport and informatics technologies will be realized within a broader societal framework encapsulating both socio-economic and technological innovations. Obviously, realistic future scenarios on such new developments are hardly available, and need to be urgently developed. A good illustration of this point can be found in current discussions on fast-speed low cost vacuum tunnels for transport needs beyond the year 2000 (see e.g. Davidson 1987).

In the light of the great many uncertainties and speculations on the implications of informatics and telematics for the spatial organisation (including transport systems) of our society, it is an interesting endeavour to have a closer look at some main results and findings from various international meetings on this issue. We will select here four international conferences devoted to the above mentioned issues, viz. the Delphi meeting on 'Informatics and Regional Development' (1986), the Toyohashi meeting on 'Information Technology and its Impact on the Urban-Environmental System' (1986), the Athens OECD-meeting on 'Information and Telecommunications Technology for Regional Development' (1987), and the Delft meeting on 'Telematics - Transportation and Spatial Development' (1988). Clearly, this selection is by no means meant to be exhaustive or entirely representative. However, we feel that certain interesting trends can be observed from these meetings.

4. The Delphi Meeting

The Delphi meeting placed informatics (the set of all modern high-tech activities involved in the design, use and management of information systems) in the centre of attention (see for a review also Giaoutzi and Nijkamp 1988). The great deal of speculations on a new 'wired society' deserved a critical look, especially as far as the impact of informatics on the spatial organisation of our societies is concerned. The main results achieved at the Delphi meeting will briefly be summarized here.

- Information and telecommunication provide appropriate vehicles for regional, urban and transport policies due to the highly regulating and controlling potential of informatics, although in a practical policy context two aspects have to be considered simultaneously, viz. (1) the need for tailor-made information in coherent regional and urban planning and (2) the need for an integrated information system in policy strategies.
- Informatics does not only influence human behaviour, but may at the same time affect the style and substance of planning.
- The New Information Technology (NIT) industry is spatially discriminating in terms of competitive pressure and restructuring of production at the regional level, so that regions seeking to attract new NIT firms may orient themselves towards transnational corporations, to 'national champion' companies or to the design of specific 'niche market' products.
- Despite the potential of telematics and informatics for regional development, it seems unlikely that the combined development of information and communication systems and electronic communication services will strengthen the socio-economic fabric of depressed areas in Europe.
- The impact of the NIT upon daily spatial interaction patterns should not be overestimated, as physical travel will always be necessary, travel and information transfer are not always substitutes but often complementary, travel has sometimes also a positive utility, and information transfer may generate new travel patterns.
- Nevertheless, NIT as a purely technical instrument (e.g., in consumption, in the service sector, or in planning efforts) will increasingly gain importance.

- Besides, telematics will no doubt have a large impact on logistic systems of firms, as economies of scale are increasingly overtaken by economies of scope.
- The spatial impacts of NIT at a broader European scale will strongly depend on technical, socio-economic and informal networks between all agencies and regions concerned.
- Although one would assume that peripheral areas would be proper candidates for a rapid implementation of NIT investments (because of its distance bridging nature), it is surprising that major agglomerations are the early adopters, whilst the space-time trajectory of NIT exhibits a clear distance-decay logistic growth curve.
- Despite the fact that high-tech industries are not by definition oriented toward central areas, the special needs of these industries (e.g., a trained labour force, availability of business services, a favourable residential climate with access to a variety of socio-cultural amenities) make a location in central areas more probable.
- Regional development policies focusing on high-tech and NIT firms may be more successful by developing integrated technology complexes - rather than isolated high-tech and NIT locations - with strong emphasis on local initiatives to be supported inter alia by the development of research/science parks.
- The existence of so-called 'filières' (integrated socio-economic and technological linkage patterns among functionally dependent firms) may stimulate the development of NIT complexes in designated and accessible areas, leaving space for a polycentric development.
- The introduction of NIT equipment in firms and planning agencies requires a re-orientation in the management style regarding previously routine administrative duties and its clerical tasks.
- Geographical information systems (GIS) are likely to become extremely important tools for planning and monitoring changes in regional, urban and transportation systems.
- NIT related hardware and software will increasingly become an indispensable component of various spatial planning activities (e.g., housing market policy, railway management, infrastructure planning).
- The introduction of expert systems and artificial intelligence may become relevant for complex and unstructured decision problems, but will never take over the role of the creative decision-maker.

5. The Toyohashi Meeting

The Toyohashi meeting (1986) focused in particular on the social, economic and geographical impacts of the new information technology (see also Orishimo et al., 1988). The following conclusions can be inferred from this meeting.

- The current logistical revolution may open many opportunities for 'creative regions' for becoming the leaders in the area of new knowledge and information creation and dissemination.
- The current information revolution raises the issue of measuring international 'trade' flows of information (instead of physical commodities), in particular because the spatial-economic impacts of information flows on various regions are likely to be much higher than those of conventional physical flows.
- In the new information age, the timing of spatial interactions and the tracing of the ensuing social implications becomes of permanent importance for planning and policy-making.
- Since public policies and regional development activities follow the usual core-periphery dichotomy, it is plausible that the information technology will follow the same pattern and will hence reinfore the existing socio-economic distribution.
- Telecommunications (including related activities such as data transmission, processing, storage and retrieval) require a satisfactory standardisation of equipment and software in order to be socially effective.
- Despite local or day-to-day changes, the overall spatial pattern of economic activities will likely not be dramatically affected by the information technology, although in some fields (e.g., transfer of knowledge, telecommuting, teleshopping) more substantial changes may take place. Most probably, existing economic centres will be reinforced by such changes.
- NIT will not become a major substitute for physical travel and face-to-face contacts, as such physical interactions are not only a prerequisite for the adoption of information technology, but may even be triggered off by an increasing use of modern information technologies.

- The impacts of information technology should not only be studied in terms of direct firm's or sectoral implications, but also in terms of indirect implications (e.g., spillover effects to other firms or sectors via an input-output network organising strategies among competitors).
- At the micro scale of cars and vehicles the information technology may have considerable impact by providing meaningful assistance for improving efficiency and safety (inter alia by means of new navigational systems).
- Much of the impact of telecommunications will depend on its tariff structure; in many countries the tariff structure is - directly or indirectly - influenced by public policies, so that tariff policies may be a useful vehicle for public interference in NIT adoption and use.
- The international or interregional distribution of labour may be drastically affected by technological improvements and innovations engendered by the information revolution (in particular, as far as the qualitative dimension of work, e.g., the need for well trained employees, is concerned).
- Also developing countries may benefit from information technology, but the main problem is to find a proper balance between the traditional socio-economic and technological infrastructure and the modern technologies.
- Changes in accessibility and changes in the penetration of information technologies (and their prices) may run parallel, so that a combined analytical effort has to be made in this context.

6. The Athens OECD-Meeting

The meeting in Athens dealt with the information and telecommunications technology for regional development (see OECD 1988).

- Information and communication technologies are of great importance for regional development, as they may provide the necessary infrastructure for modernizing or restructuring regional activities.
- Information and communication technologies do not automatically generate regional growth, but have to be combined with other locational factors (e.g., existence of well trained personnel).
- The impact of information and communication technologies on regional welfare is not only dependent on the technical

availability of these technologies (in terms of production, distribution and exchange), but also on the economic and socio-cultural conditions favouring the adoption of these technologies. Consequently, regional disparities are not necessarily reduced through these new technologies.

- The price to be paid for telecommunications services may have a great impact on various spatial interaction patterns, so that in this field tariff policies may become an element of a regional development policy.
- The economic restructuring which is necessary for an efficient use of informatics and telecommunications may lead to a comparative competitive advantage of advanced industrial nations or regions vis-à-vis lower developed nations or regions, especially because lower labour force qualifications (and hence low wage costs) are not any more important locational elements of new technologies.
- The slow adoption of informatics and telecommunications in peripheral areas (caused inter alia by the lack of an advanced (tele)communications infrastructure) and the rise of tradeable information services in central areas is likely to favour core regions even more.
- Lags in using modern informatics and telecommunications may also hamper the necessary broader technological restructuring in older industrial (and sometimes less central) regions.
- The technical shift from hierarchical diffusion patterns of the information and (tele)communication services to a footloose provision (caused e.g. by satellite and digital systems) may still offer a great potential for peripheral areas (cf. the STAR programme of the European Community focussing on the design of advanced telecommunication technologies).
- The structure of (computerized, organisational or informal) networks is decisive for the spread pattern of information and communication services.
- A higher penetration of informatics and telecommunications in less developed nations or regions is only reached if economies of scope (based on tailor-made supply features) are more emphasized.
- The increase in the use of information and telecommunications services will induce a further globalisation of national and regional economies, so that the physical barriers of distance may decline in importance.

- Labour force policy seeking to improve the matching between supply and demand at the labour market (e.g., by improving the skills of people) is a meaningful indirect way of attracting new technologies to lagging areas.
- Specific tailor-made industrial development policies (e.g., focusing on the growth of the small and medium size sector) would be another vehicle for a better integration of informatics and telecommunications in local economies.
- A more integrated 'network culture' through educational and training programmes may partly remove the geographically discriminating effects of the modern informatics and telecommunications sector.

7. The Delft Meeting

The recent meeting in Delft focused attention on telematics in relation to transportation and spatial development (see also Drewe et al, 1988). Telematics was regarded here as those applications of computer techniques and information engineering for which the bridging of significant physical - and any related organisational or cultural - distances by network connection is an essential feature. At this meeting the following conclusions were reached:

- A successful introduction of telematics is not only a technical matter, but requires also innovations in the organisation of work, management strategies, infrastructural developments, and public and private service sectors (including education).
- Telematics is often not a substitute for physical transport, but a complementary service aiming at increasing the economic efficiency of transport.
- Telematics may provide opportunities to substitute travel when the primary purpose of the trip-making is a transfer of information, but for shopping trips, business travel and commuting these substitution opportunities are much lower (although for routine shopping activities telematics may provide a meaningful option).
- Telematics as such is an environment-friendly technology (including its replacement of some physical transport), but the resulting spatial deconcentration may again be harmful to the environment in the long run.
- In many countries the use of telephones appears to provide more possibilities for substituting physical travel than other communications tools like telefax, telex or video.

- In a normal business firm it is common practice to judge the available facilities for carrying out transactions on the basis of criteria such as cost, comfort, productivity, efficiency, and the like, so that in this context telematics and transportation are to be seen as an integrated system in which the relative use of these modes is determined by the company's interest.
- Especially for long distance and international (commodity and person) transport telematics may become an important vehicle for increasing the speed of handling barriers (e.g., in case of customs' formalities).
- The design and implementation of so-called teleports providing a location to information intensive firms may lead to new geographical core areas in a spatial economic structure, in which especially internationally oriented business activities may be stimulated.
- Modern electronic systems of traffic control, traffic management, route guidance and demand management systems have an enormous potential and will no doubt be further introduced in order to increase the efficiency of travel.
- Road and vehicle safety can be considerably increased by means of intra-vehicle, vehicle-to-vehicle, and vehicle-environmental communications (see also the European Prometheus programme focussing on the design of technologically advanced, safe and environment-friendly cars).
- New logistic systems will favour not only operational and tactical decisions of firms, but also their strategic decisions regarding production, distribution and transport.
- Telematics will not only have an impact on the external flows of the firm, but also on its internal scheduling of commodity production.
- In general, multi-plant firms and larger firms have a much higher utilisation rate of telematics than others.
- The diffusion of telematics among different regions in a country is in general not uniform, and hence this irregular regional distribution tends to increase the existing disparities in regional development.

8. Concluding Remarks

The observations presented in sections 4-7 show a great deal of variation, but also various communalities. Some conclusions reflecting the authors' personal views will briefly be presented here.

The impact of informatics and telematics upon the spatial locational pattern of business firms and households is likely to be moderate, as spatial redistribution processes induced by NIT are governed by two antagonistic forces: a higher potential for a spatial dispersion of activities toward the periphery and a strong incubation potential of new technologies in urban agglomerations. Clearly, the ultimate outcome will be determined by the specific type of production activities and of households involved. Peripheral areas are in this respect not always in a good position to acquire the fruits of NIT in an early phase.

Next, the impact of informatics and telematics upon physical travel may ultimately be fairly moderate, as here also two antagonistic forces are at work: an increase of substitution possibilities with respect to physical transport and an increase in the need for travel and transport after the introduction of advanced communication systems.

However, even if no dramatic impacts of NIT on the overall locational map of Western countries or of Europe as a whole are to be expected, NIT may still exert significant impacts. Early adoption of NIT increases regional competitiveness and efficiency and hence has a positive influence on a region's relative position in a highly competitive international market.

Far reaching changes are likely to take place also in the area of new logistic systems and traffic guidance systems. Qualitative improvement - rather than substitution - is likely to be the result of the adoption of NIT. The same holds true for the potential contribution of NIT to safety and environmental quality.

Finally, informatics and telematics may at best level off the increase in spatial mobility and transport. NIT may act as both a substitute and a complement to physical travel, so that it is hardly possible to draw unambiguous inferences on its ultimate result.

Despite this modest role of NIT, however, informatics and telematics may still be regarded as important policy vehicles for both a geographical restructuring (e.g., in the context of a regional development policy) and for the enhancement of the efficiency of a spatial-economic system.

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